966,369

PATENT SPECIFICATION

DRAWINGS ATTACHED

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COMPLETE SPECIFICATION

Leakage Detection in a Fluid-flow Cooling System of an Electric Machine

We, SIEMENS-SCHUCKERTWERKE AKTIENGESELLSCHAFT, a German Company of Berlin and Erlangen, Germany, do hereby declare the invention, for which we pray that a patent may be granted to us, and the method by which it is to be performed, to be particularly described in and by the following statement: —

This invention relates to leakage detection in a fluid-flow cooling system of an electric machine.

According to the invention there is provided an installation comprising an electric machine having means associated therewith to pass a liquid cooling medium through parts thereof and also having within the machine, to cool other parts thereof, a gaseous cooling medium at a higher pressure than the liquid cooling medium and having a substantially different dielectric constant than the liquid cooling medium, there being a capacitor arranged to have the liquid cooling medium pass between its electrodes and detecting means for detecting a change in the capacitance value of the capacitor such as will occur in the event of the gaseous cooling medium leaking into the liquid cooling medium and subsequently passing between the electrodes.

The requirement to detect leakage of the gaseous cooling medium into the liquid cooling medium arises out of the fact that the cooling can be detrimentally affected by such leakage, for example owing to the formation of bubbles. We, in Germany, are aware of prior proposals to detect such leakage by means of gas analysis devices. It can also be done by pressure-measuring devices, since pressure increases occur in the liquid cooling system when gas passes into it. The detection of the leakage by detecting a change in capacitance is considered to be an improvement.

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The two cooling media are preferably distilled water, which has a dielectric constant of about 80 and hydrogen which has a dielectric constant of about 1. Consequently if the hydrogen enters the water and subsequently flows between the electrodes of the capacitor, there occur, even when relatively small gas volumes or gas bubbles are present, appreciable capacitance changes which can be detected with high accuracy.

For a better understanding of the invention and to show how it may be carried into effect, reference will now be made to the accompanying drawing, in which: —

Figure 1 illustrates diagrammatically an installation comprising an electric machine, a fluid-flow cooling system and a leak detecting arrangement, and

Figures 2 and 3 illustrate two possible constructions of a capacitor forming part of the leak-detector arrangement of Figure 1.

In the installation shown in Figure 1, a turbo-generator has its stator winding system 2 cooled with distilled water which passes through hollow stator conductors and which is supplied to the machine through a duct 3 from a re-cooling system 4 by means of a pump 5. The machine is filled with hydrogen, which is circulated by fans 6 and flows both through the rotor 7 and through the iron laminations 8 of the stator. Disposed in a metallic duct 10 directly beyond the water-cooled stator winding is a capacitor 11, between the electrodes 12 of which the water flows before reaching the re-cooling system 4. The water constitutes part of the dielectric of the capacitor, the remainder being solid insulating material which insulates the electrodes 12 from the water and from the duct.

If a leakage is present in the winding through which the water is passed, the

hydrogen in the machine housing enters the water-cooling system because it is at a higher pressure than the water. Small gas inclusions or bubbles are formed in the water. When these gas inclusions or bubbles pass between the electrodes 12, the capacitance value of the capacitor 11 changes appreciably owing to the large ratio between the dielectric constants of the water and the hydrogen. Experiments have shown that even small gas bubbles are sufficient to bring about a measurable capacitance change. The capacitor 11 is connected in parallel with an inductor 15, the inductance of which is adjustable, and the two are connected to a high frequency oscillator 16, the frequency of which is equal to the frequency at which parallel resonance occurs in the circuit consisting of the capacitor and the inductor when there is no gas between the electrodes 12. When a leakage occurs and the gas passes between the electrodes 12, the parallel circuit becomes non-resonant and this change is detected by reason of the parallel circuit being connected to an amplifier 21 which supplies a relay device 22 having switch contacts which are actuated in response to disturbances in the resonant circuit.

As is shown in Figure 2, the capacitor may have flat rectangular electrodes 31 with a passage 30 of rectangular cross-section between them for the water. Alternatively, as indicated in Figure 3, the electrodes may be concentric hollow cylinders 32 between which is an annular space 33 through which the water flows. The electrodes af the capacitor are insulated by a layer 34 of plastic material.

WHAT WE CLAIM IS:—

1. An installation comprising an electric machine having means associated therewith to pass a liquid cooling medium through parts thereof and also having within the machine, to cool other parts thereof, a gaseous cooling medium at a higher pressure than the liquid cooling medium and having a substantially different dielectric constant than the liquid cooling medium, there being a capacitor arranged to have the liquid cooling medium pass between its electrodes and detecting means for detecting a change in the capacitance value of the capacitor such as will occur in the event of the gaseous cooling medium leaking into the liquid cooling medium and subsequently passing between the electrodes.

2. An installation according to claim 1 and having distilled water in the machine as the liquid cooling medium.

3. An installation according to claim 1 or 2 and having hydrogen in the machine as the gaseous cooling medium.

4. An installation according to any preceding claim wherein the capacitor is connected to an inductor and the two are connected to a source of alternating current and resonance occurs when no gaseous cooling medium is between the electrodes, and wherein the detecting means is such as to detect the arrangement of the capacitor and the inductor becoming non-resonant when gaseous cooling medium is between the electrodes.

5. An installation according to claim 4, wherein the inductance of the inductor is adjustable.

6. An installation according to any preceding claim wherein the detecting means actuates switch contacts when it detects a capacitance change as aforesaid.

7. An installation according to any preceding claim wherein the electrodes of the capacitor are placed in a metallic duct through which the liquid cooling medium flows and are insulated both from the duct and from the cooling medium therein.

8. An installation comprising an electric machine, a cooling system and a leak-detecting arrangement substantially as hereinbefore described with reference to Figure 1 of the accompanying drawing or Figures 1 and 2 or 1 and 3.

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1 SHEET

COMPLETE SPECIFICATION

This drawing is a reproduction of the Original on a reduced scale.

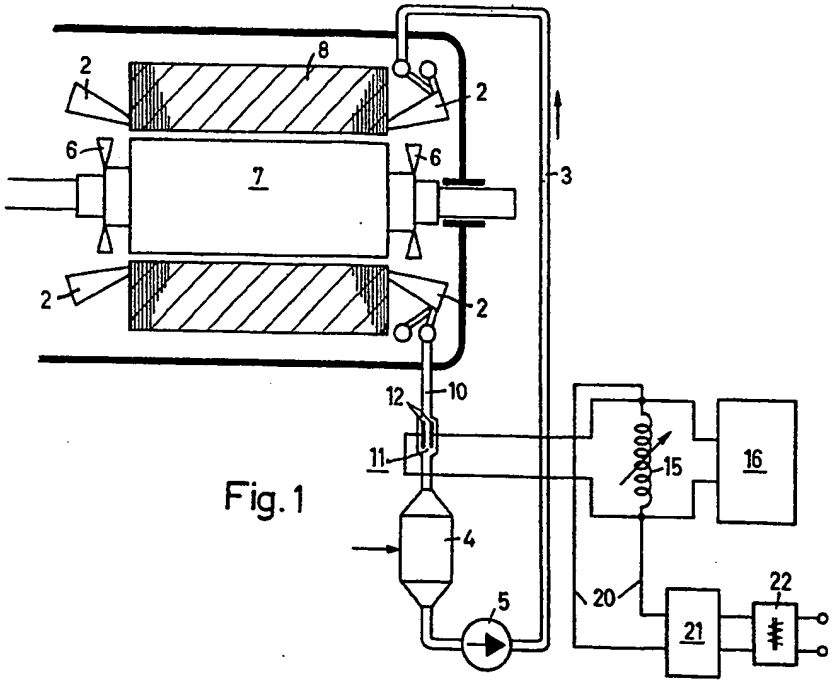

Fig. 1

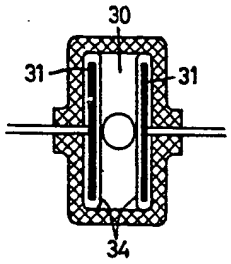

Fig. 2

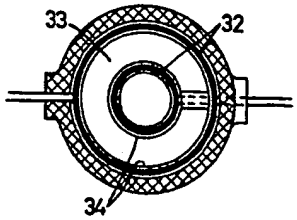

Fig. 3